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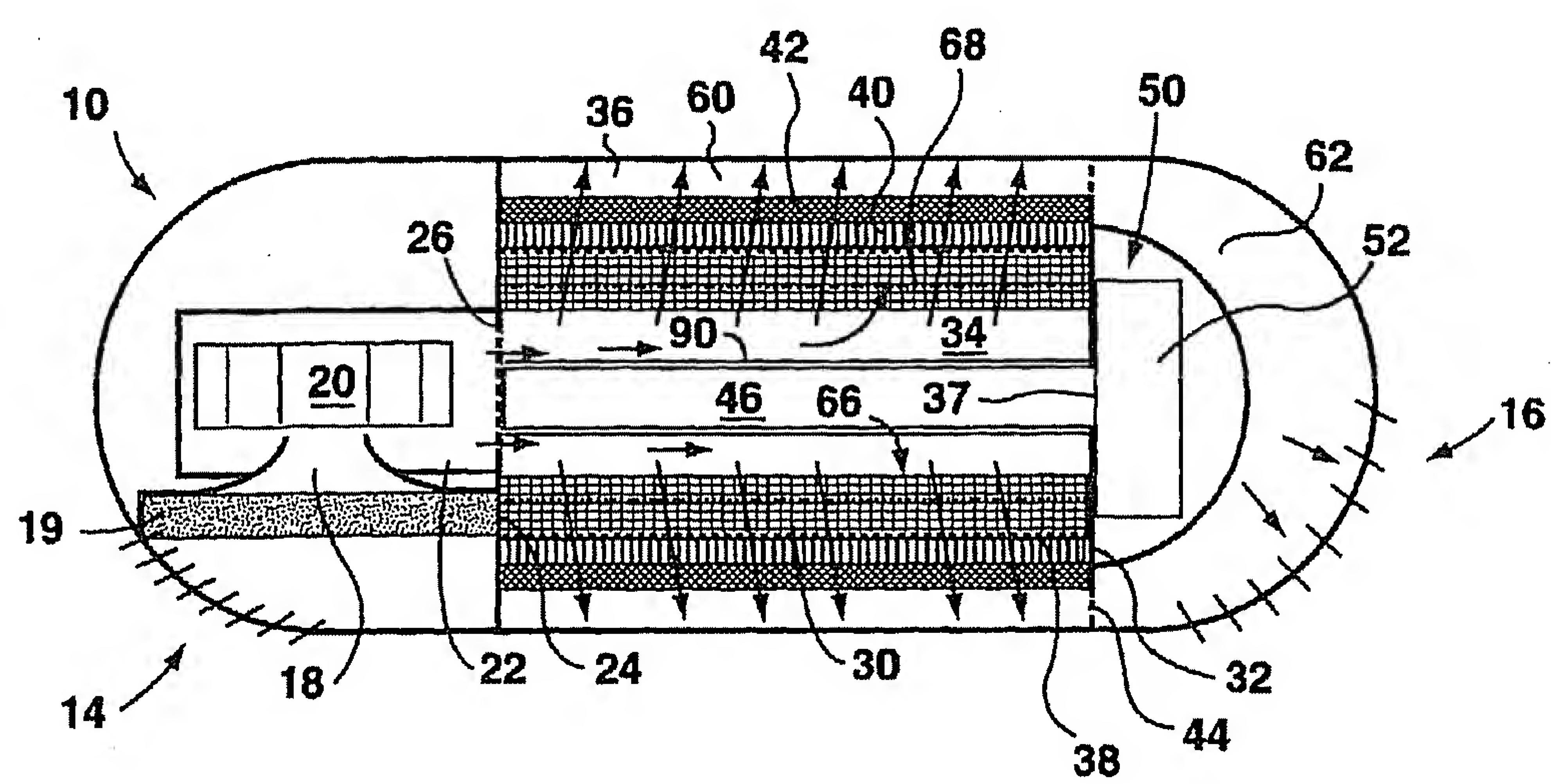
(54) Title: AIR PURIFIER



(57) Abstract: An air purifier has an air flow path with a dielectric body (30) interposed across the path. The dielectric body may be made of, for example, quartz or alumina fibres or silica granules or sponge so that it is porous to air and transmissive to ultraviolet ("UV") light. A source (46, 50) of ultraviolet light emits UV1 and UV2 light into the airflow path upstream of the dielectric body and at least UV2 light into the dielectric body itself. The UV light forms ozone. The ozone, as well as water vapour in the air, naturally attaches to the dielectric body which concentrates these materials in the dielectric body. The UV light irradiating the ozone and water in the dielectric body causes the formation of highly reactive hydroxyl radicals which assist in sterilising the incoming air.

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AIR PURIFIER

BACKGROUND OF THE INVENTION

This invention relates to an air purifier and to a method of air purification.

It is known that ultraviolet ("UV") light sterilizes DNA so that biological material (such as viruses, bacteria, molds, yeasts, and pollens) exposed to UV light either dies or cannot reproduce. This property of UV light has been utilized to sterilize air in a building by simply placing UV lamps in the building's air ducts. One drawback with this approach is that biological material may not be exposed to UV light for a sufficient time to be sterilized. To address this drawback, it is known to utilize a porous air filter and mount a UV light for reciprocating movement across a face of the filter. In operation, a fan draws air through the filter resulting in biological material becoming trapped in the filter. The irradiation of the filter with the reciprocating UV light acts to kill this trapped biological material. However some biological material, namely viruses, readily pass through porous filters and would not, therefore, be sterilized with the combination of a porous filter in conjunction with a UV lamp. Furthermore, UV light degrades a porous filter requiring frequent replacement of same.

In our U.S. patent no. 5,656,242 issued August 12, 1997, we describe several air purifiers which sterilise air with UV radiation. In one embodiment air is drawn through a filter and a perforated metal plate into a primary radiation cavity containing a UV light. The filter traps biological material which is exposed to a low UV dose via the perforations in the metal plate. In another embodiment, air is drawn along a U-shaped path defined by a filter transmissive to UV2 and blocking UV1. UV1 and UV2 radiation generated by a lamp in the first leg of the U-shaped path forms sterilising ozone (O_3) in this leg; the UV2 which passes through the filter into the second leg of the U-shaped path breaks down this ozone. Water misters in this second leg result in the disassociated ozone forming hydroxyl radicals (OH) which further sterilise the air. Thus, the air is sterilised directly by the UV radiation and also indirectly by the UV radiation creating ozone and hydroxyl radicals. While this embodiment results in an effective purifier, water misters may not be readily available and increase maintenance needs of a system.

Therefore, there remains a need for an effective air purifier.

SUMMARY OF INVENTION

An air purifier has an air flow path with a dielectric body interposed across the path. The dielectric body is fabricated so as to be porous to air and transmissive to ultraviolet ("UV") light. A source of UV light emits UV light into the dielectric body and, optionally, also into the air flow path upstream of the dielectric body. The UV light may form ozone. Ozone, as well as water vapour in the air, naturally attaches to the dielectric body which concentrates these materials in the dielectric body. The UV light irradiating the ozone and water in the dielectric body causes the formation of highly reactive hydroxyl radicals which assist in sterilising the incoming air.

Accordingly, in one aspect, there is provided an air purifier comprising: an air flow path; a dielectric body which is porous to air and transmissive to ultraviolet light interposed across said air flow path; and a source of ultraviolet light for emitting ultraviolet light such that ultraviolet light is present in said dielectric body.

According to another aspect of the invention, there is provided an air purifier comprising: an air flow path; a dielectric body interposed across said air flow path, said dielectric body being porous to air and fabricated of at least one of silica, silicon dioxide, aluminum oxide, magnesium fluoride, calcium fluoride, barium fluoride, strontium fluoride, lithium fluoride, quartz and sapphire; and a source of ultraviolet light for emitting ultraviolet ("UV") light such that ultraviolet light is present in said dielectric body

According to a further aspect of the present invention, there is provided a method of air purification comprising: passing contaminated air through a dielectric body which is porous to air and transmissive of ultraviolet ("UV") radiation; and UV irradiating said dielectric body.

BRIEF DESCRIPTION OF THE DRAWINGS

In the figures which illustrate example embodiments of the invention,

Figure 1 is a schematic side view of an air purifier made in accordance with an embodiment of this invention,

Figure 2 is a schematic top view of the purifier of **Figure 1**,

Figure 3 is a schematic cross-sectional view along the lines 3-3 of **Figure 2**,

Figure 3a is a graph of UV intensity versus radial distance, and

Figure 4 is a schematic side view of an air purifier made in accordance with another embodiment of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referencing **Figures 1** to **3**, an air purifier **10** has a housing **12** with an air intake **14** and an air exhaust **16**. Within housing **12**, an intake plenum **18** extends from the air intake **14**, through a dust filter **19**, to the suction inlet of a blower **20**. An outlet plenum **22** extends between the outlet of the blower and an annular wall **24** inwardly depending from housing **12**. Annular wall **24** has a concentric aperture covered with an ultra-violet ("UV") reflecting screen mesh **26** which allows the flow of air but which reflects UV. An annular dielectric body **30** extends between annular wall **24** and a second annular wall **32** inwardly depending from the housing to define a central cavity **34** and a peripheral annular cavity **36**. Dielectric body **30** is enveloped by a screen mesh sleeve **38**, a particulate filter **40**, and a chemically absorbent filter **42**. Sleeve **38** may, optionally, be provided with a UV coating on its inside surface such that it allows the transmission of air but reflects UV. The second annular wall **32** has a central opening **37** and a peripheral annular, UV reflecting, screen mesh section **44**. The gas containing tube **46** of an ultraviolet lamp **50** extends through the opening **37** of wall **32** into cavity **34**. The ballast **52** of lamp **50** is secured to wall **32**.

Walls **24** and **32** along with the wall of the housing **12**, define a UV chamber **60**. The walls of this UV chamber many have a UV reflective coating. The outer cavity **36** opens into an exhaust plenum **62**.

An inner member, shown as annular inner wire mesh **66**, lines the inside wall of the dielectric body **30** and an outer member, shown as annular outer wire mesh **68** is embedded within the dielectric body **30**. A voltage source **70** (**Figure 3**) is connected (through a switch-not shown) between the inner mesh **66** and mesh sleeve **38**, on the one hand, and outer wire mesh **68**, on the other. Each mesh might be in the form of thin metal (Al with gold, rhodium or nickel coatings) radial blades which would reflect UV by grazing incidence but intercept significant amounts of light.

The intake and exhaust plenums **18** and **62** may be coated with a UV absorbing paint which, optionally, may be impregnated with a UV activated biocide such as TiO_2.

The UV lamp **50** may emit UV1, UV2 and UV3 radiation. UV1 radiation is defined as UV radiation below approximately 185 NM in wavelength, UV2 is defined as radiation between 185 and 300 NM in wavelength and UV3 is defined as UV radiation above 300 NM in wavelength.

UV1 radiation photo dissociates O_2 into ground state atomic oxygen (O) and water vapor into hydroxyl free radicals (OH) and hydrogen (H). UV2 radiation photo dissociates O_3 into O_2 and excited atomic oxygen (O*). These dissociation processes create powerful oxidants which can oxidize both bio-aerosols and volatile organic compounds rendering them either harmless, or converting them into species which are readily absorbed by filters. UV3 radiation does not photo dissociate any gaseous species but can excite photo catalysts, such as surfaces of TiO_2 and similar semiconductor catalysts.

All of these species will attach to surfaces in the annular dielectric **30** resulting in a concentration of the processes of oxidation. In this regard, when voltage source **70** is switched in, photo-electrically generated electrons from the inner wire mesh **66** and mesh sleeve **38** flow towards the oppositely charged outer mesh **68**. These electrons attach to particulate and to the outer wire mesh **68**. Such charge attachments retard the flow of the particulate enhancing the UV exposure by increasing the exposure time. In addition, electrostatic attachment of the particulate to the outer filters is enhanced increasing the efficiency of the filtration of the particulate.

The photoelectric effect is enhanced at shorter wavelengths for many materials. Thus using the inner wire mesh **66** as the cathode, which is near the lamp, would allow UV1 to be used to eject photo-electrons. An alternate method to using a mesh would be to coat a thin metal transparent conductive film directly on the lamp. Such cathodes (usually called semitransparent) are commonly used in optical sensing devices. This cathode should absorb only a tiny amount of UV1 exiting the lamp but could be highly photo-emissive by virtue of the enhanced quantum efficiency at shorter wavelengths. A very thin layer of gold, nickel, rhodium or other metal might be used. Cesium iodide or cesium telluride (in small quantity or low concentration) might also be used.

The inner mesh cathode **66** of the dielectric body may be coated with a UV reflective coating or may be constructed with a UV reflective material such as aluminum or aluminum coated with rhodium. This would concentrate the UV1 and UV2 in the central cavity **34** increasing the kill of bio-aerosols and photo-dissociative effects in the air. In addition, UV enhancement in the central chamber will not be at the expense of UV reaching the dielectric body if the reflective coating has a low absorbance. This occurs since the intensity of light inside the central cavity **34** will increase proportionately to the reflectance of the inner mesh cathode **66**. Even though the cathode will transmit a smaller percentage of the light striking it, a larger amount of light will be available at its surface. Thus, a higher intensity of UV can be gained inside the central cavity **34** while preserving the flux into the annular dielectric body **30**.

The UV reflective coating of the UV chamber **60**, the inner mesh cathode **66**, and the screen mesh sleeve **38** may be comprised of rhodium coated aluminum which can exhibit both high reflectance and a photoelectric effect. It may also be pure aluminum with a very thin protective film to protect it from oxidation but which will allow photoelectrons to escape. Such a film might be comprised of pure aluminum oxide, magnesium fluoride, or other fluoride material. The coating might also be comprised of an alkali metal with high UV reflectance in pure form and high photoelectric effect with a thin oxidation protective film such as a fluoride. The mesh size of the screen mesh sleeve **38** is chosen so that the preponderance of UV light reaching the sleeve is reflected. One way of achieving this is to keep the mesh size less than one tenth the size of the smallest wavelength to be reflected in

a conductive mesh. In this fashion the mesh could serve as a particulate filter as well as a light reflector.

Unlike UV2 and UV3, UV1 radiation forms ozone which is a toxic gas. Consequently, it is desirable that most, or all, of the UV1 radiation be absorbed within central cavity **34** so as to reduce the prospect of ozone leaking from purifier **10**.

The radial extent of the central cavity **34** of UV chamber **60** may therefore be dependent on the largest wavelength of UV1 produced by lamp **50**. More particularly, in some embodiments of the invention, it may be desirable to have the most of the UV1 at no greater than 170 NM. In such instance, even with the radial extent of the inner cavity being on the order of a few mm, most of the UV1 radiation will be absorbed by the air of the inner cavity **34**. On the other hand, if the lamp produces UV1 at up to 185 NM, the radial extent of the inner cavity would need to be on the order of at least 10 cm for most of this radiation to be absorbed while traversing the inner cavity.

The dielectric body **30** is formed so as to be porous to air. Consequently, an air flow path is defined from purifier air intake **14**, through the blower **20**, into the central cavity **34** of the UV chamber **60**, then through the annular dielectric body **30**, the screen mesh sleeve **38**, outer particulate filter **40**, outer chemically absorbent filter **42**, into the outer cavity **36** and out the air exhaust **16**.

The dielectric body **30** is fabricated of a porous dielectric material which transmits UV radiation. Suitable materials could include:

1. Silicon dioxide or pure silica in the form of fiber, sponge or frit
2. Silicon dioxide or pure silica in the form of an aerogel or xerogel
3. Silica gel granules
4. Silica gel granules coated onto silicon dioxide fibers or frit
5. Aluminum oxide (high purity) fibers, frit or granules
6. Aluminum oxide (high purity) coated aluminum fiber

7. Magnesium fluoride, calcium fluoride, barium fluoride, strontium fluoride or lithium fluoride powers, fibers, frits or coatings on transmitting or reflecting substrates.
8. Quartz fiber, quartz fiber with silica gel coating.
9. Sapphire fiber.

Other dielectric matrices with air passageways may also be used. Two properties are, however, needed: that the dielectric body transmit UV (UV1, UV2 and UV3) and that ozone and water vapour attach to the dielectric body. The latter property increases the availability of these species for photo-catalytic reactions which convert UV light into hydroxyl free radicals.

Water vapour and ozone will attach (i.e., bond) to all dielectrics to at least some extent. However, in some dielectric materials this property is particularly pronounced. For example it is well known that silica gel can absorb up to 30% of its mass of water vapor and ozone. For any dielectric material, the ability to attach to ozone and water vapour will increase if the material is provided with a large surface area. This suggests that the porous dielectric body should have relatively small pores to increase surface area (limited only in that the pores should not be so small as to inhibit the admission of the molecules of water and ozone).

Optionally, the dielectric body is fabricated of a material which more strongly absorbs UV1 radiation than it does UV2 radiation. This may be desirable where the radial extent of the inner cavity is such that an appreciable portion of the UV1 radiation is not absorbed in the air of the central cavity **34**. One suitable dielectric material with this property is quartz which, depending on the grade, will absorb more strongly at wavelengths below 185 nm than for wavelengths above 185 nm. Another material which may be suitable is aluminum oxide, provided it has sufficiently high purity to transmit UV.

The outer particulate filter **40** may be a pleated fabric filter or a fiber filter, which will trap biological contaminants such as virus, bacteria and moulds. UV light that transmits through the screen mesh sleeve **38** will sterilize the biological material on the filter. The outer chemically absorbent filter **42** may be a charcoal or zeolite filter, both of

which will trap gaseous chemical contaminants as well as biological material. The life of outer filter **42** will be enhanced if it is placed after (in the air flow sense) the particulate filter. This will insure that its absorbent material pores do not clog with micro particles. Filter **42** will serve to remove any residual organic breakdown fragments from the photochemical reactions that oxidize volatile organic compounds in the dielectric body **30** insuring the safety of the device.

Since UV2 and UV3 are expected to penetrate into the two outer filters **40, 42**, photocatalytic materials such as TiO_2 may be added to either or both of these filters. This will produce a continuous cleaning effect, which may serve to cleanse the filters of organic particulate material, enhancing their lifetimes. The dielectric body **30** will also produce hydroxyl free radicals in the gas phase which will be entrained in the gas flow and which will also serve to continuously clean the filters of particulate. The dielectric body may also be coated with a photocatalytic material such as TiO_2 to enhance the destruction of volatile organic compounds.

Since UV3 will be readily transmitted through many materials, it is expected to make its way through the outer filter **42** and into the outer cavity **36**. The outer wall of housing **12**, which can also be coated with photo catalytic material, can then absorb UV3. Since the appropriate concentration of this material will act as a strong UV absorber, the outer wall will both absorb residual UV and add to the overall volatile organic compound removal by the device.

In operation, both the blower **20** and UV lamp **50** are activated and the switch to voltage source **70** is closed. The voltage then polarizes inner mesh **66**, mesh sleeve **38**, and outer mesh **68** establishing an electric field between the inner mesh and the mesh outer mesh and between the mesh sleeve and the outer mesh. Further, the UV radiation from lamp **50** results in photo-emission of electrons from the inner mesh **66** such that this mesh acts as a cathode. These electrons are attracted toward the outer mesh (which therefore acts as an anode) but attach themselves to the dielectric body **30** along the way. The body retains the static charge owing to its high electric impedance. (Note that a dielectric body **30** fabricated of quartz fibres is particularly advantageous in this regard due the high electrical resistance of quartz). This effect enhances the electric field established in the

body **30**. Blower **20** draws contaminated air from intake **14**, though intake dust filter **19**, and expels it into the central cavity **34** of UV chamber **60**. The pressurized air in the inner cavity **34** moves downstream from the inner cavity **34** through dielectric body **30** to the outer filters **40** and **42**. In doing so, much of the biological material (such as bacteria and viruses) in the air becomes trapped in the electric fields set up between meshes **38**, **66**, and **68**. Further, water vapor and ozone in the air is absorbed by the dielectric body **30**. These materials are converted to OH both in the gas phase and on the dielectric fill. As the air passes through outer filters **40** and **42**, residual biological material and chemicals are removed from the air. Both are destroyed by the wash of residual UV2 and by OH that is entrained in the air.

With lamp **50** activated, **Figure 3a** graphically illustrates the intensity of UV1, UV2 and UV3 radiation as a function of radial distance in the lamp cross-section illustrated in **Figure 3**. Turning to these figures, it will be seen inner cavity **34** of UV chamber **60** is flooded with UV1, UV2 and UV3 light (section **100**) and the dielectric body **30** is flooded with (predominately) UV2 and UV3 light (section **102**). A small amount of UV2 light passes through screen mesh sleeve **38** and into filters **40** and **42** (section **104**). The UV reflective coatings of walls **24** and **32** as well as of housing **12** and inner mesh **66** enhance the intensity of UV radiation in the central cavity **34**. The UV reflective coating on walls **24** and **32** and on the screen mesh sleeve **11** enhance the intensity of UV radiation in the dielectric body **30**. The UV absorbing coatings of intake plenum **18** and exhaust plenum **62** help ensure that any UV light reaching these extremities of purifier are absorbed and do not leave the purifier (section **106**).

The UV radiation produced by lamp **50** produces the following chemical reactions.

$$O_2 + UV1 \rightarrow O + O \qquad (1)$$

$$O_2 + O \rightarrow O_3 \qquad (2)$$

$$O_3 + UV1 \text{ or } UV2 \rightarrow O^* + O2 \qquad (3)$$

$$O^* + H_2O \rightarrow 2OH \qquad (4)$$

$$O^* + O_2 \rightarrow O_3 \qquad (5)$$

$$H_2O + UV1 \rightarrow OH + H \qquad (6)$$

$$O + O_2 \rightarrow O_3 \qquad (7)$$

As will be appreciated by those skilled in the art, these reactions have been simplified. In fact, other free radicals (such as H and HO_2) and compounds (such as H_2O_2) will play roles.

UV1 radiation produced by lamp **50** photo-dissociates oxygen (O_2) in the air resulting in the formation of ground state atomic oxygen (reaction (1)). This atomic oxygen is highly chemically reactive. A large portion of this atomic oxygen reacts with O_2 to form ozone (O_3: reaction (2)). Ozone may be further photo-dissociated by UV1 or UV2 to form excited atomic oxygen (O^*: reaction (3)). As will be appreciated by those skilled in the art, the optimum UV wavelength for dissociating ozone is about 250 nm. This excited atomic oxygen is even more chemically reactive than the oxygen formed in reaction (1) and rapidly attacks any water vapor present to form OH by reaction (4). The excited atomic oxygen can also be deactivated by oxygen (O_2) and nitrogen (N_2) in the air to form ground state atomic oxygen which then reacts with O_2 to reform ozone (reactions (5), (6) and (7)).

Atomic oxygen, ozone (O_3) and hydroxyl radicals (OH) will react with organic compounds and break them into oxidized fragments. However, OH removes most organic compounds at rates up to ten orders of magnitude faster than ozone. Further, ozone is a toxic gas. OH, on the other hand, is not a hazard because it is so chemically reactive that is cannot survive more than a few second in normal air. Thus, unlike ozone, it cannot accumulate.

In view of the forgoing it is desirable to create as much OH and a little ozone as possible. This means enhancing reactions (3) and (4) relative to reactions (5) to (7). This is

achieved by dielectric body **30** which traps ozone, thereby increasing the rate of its photo-dissociation by reaction (3), and which traps water vapor and ozone for use in reaction (4).

A highly porous dielectric body can absorb water or ozone to up to about 30% of its weight. The high absorbency and higher density of the dielectric body **30** relative to air results in an enhancement of the volume density of water and ozone of about three orders of magnitude. The dielectric body will absorb water vapor even when relative humidity is low making it unnecessary to add water vapor to the system.

Because UV1 is primarily or entirely contained within inner cavity **34** of UV chamber **60**, it will be apparent that atomic oxygen is primarily formed in the inner cavity (reaction 1). Ozone will therefore be formed (by reaction 2) in the inner cavity and in the dielectric body. Because the body **30** is primarily radiated with UV2, little ground level atomic oxygen (O) – which generates ozone – will be formed in the body. Instead, the UV2 irradiating the body will primarily photo-dissociate the ozone trapped by the body resulting in excited atomic oxygen (reaction (3)). Given the high concentration of water vapor in the body **30** and the presence of excited atomic oxygen there, OH (by reaction (4)) is formed primarily in the dielectric body.

If a suitable dielectric material is added to the inner cavity **34**, or if a porous UV1, UV2 and UV3 transmitting dielectric is coated onto the lamp walls, the production of OH by reaction (6) will increase relative to reactions (1) and (2). This enhancement results from the high absorption of H_2O relative to O_2 onto the surfaces of many dielectrics (e.g. silica gel or aluminum oxide). This effect can be useful in embodiments in which it is desirable to further minimize ozone production.

For example, by applying a pure silica gel coating **90** (**Figure 1**) which is a few millimetres thick to the light emitting tube **46** of the lamp **50** of **Figures 1** or **4**, the H_2O present in the coating will absorb all the UV1, converting the H_2O directly to OH. This will reduce the ozone production but will not block UV2 and UV3 radiation from the lamp.

As noted, the OH and atomic oxygen will fragment (oxidize) organic compounds thus destroying bacteria and viruses in the air. This will also result in fragmentation of other volatile organic compounds and organic pollutants which may be in the air, thereby reducing their concentration.

Organic compounds may stick to the dielectric body **30**. However, OH will rapidly attack these surface contaminants thereby fragmenting these materials. If the fragmented materials continue to stick, they continue to be fragmented until, in many cases, water vapor and carbon dioxide results. Carbon dioxide (CO_2) is not absorbed by zeolite or charcoal. Thus, where the outer chemically absorbent filter **42** is fabricated of such materials, CO_2 will float away and out of the purifier. Since the concentrations of volatile organic compounds are small (less than a part per million) compared to the ambient concentration of CO_2 (about 300 parts per million), any increase in CO_2 caused by the oxidation of volatile organic compounds by the purifier is negligible compared to other sources and will pose no health risk.

The UV light itself will also act to sterilize biological materials in the intake air. This is particularly so in respect of material trapped by the electric field in the body **30** or trapped in outer filter **42** in view of the increased time during which such biological materials is exposed to the UV light.

Ozone reaching the outer filter **42** is readily absorbed. While it is absorbed on the filter it will be broken down by the (small) amount of UV (UV2) radiation reaching outer filter **42** and will form OH. This reaction can be facilitated by adding a catalytic mesh (with a material such as TiO_2) to these filters.

Screen mesh **38** could be replaced with a porous wall formed of fused UV reflecting grains having a diameter approximating that of the UV2 radiation. These UV reflecting grains could, for example, be spheres of aluminum, high purity silica, or grains of barium sulfate. It might also be fabricated out of aerogel matrices with the desired average pore sizes.

While lamp **50** is described as emitting UV1, UV2 and UV3 radiation, air will still be purified by the purifier **10** (albeit not as efficiently or completely) if the lamp emitted solely UV1 or UV2 radiation. Further, two or three lamps could be provided, one which emits UV1 radiation into the airflow path upstream of the dielectric body, a second one which emits UV2 light into the dielectric body itself and a third one which emits UV3 radiation for use in the outer filters and outer wall.

Figure 4 illustrates an air purifier **100** in accordance with another embodiment of this invention. Turning to **Figure 4**, wherein like parts have like reference numerals, housing **112** of purifier **100** is tubular. Air inlets **114** in one end of the housing feed to blower **120**. An outlet plenum **22** extends between the exhaust of the blower and the central cavity formed by the annular dielectric body **30**. An annular plate wall **132** abuts the end of the dielectric body **30** remote from plenum **22**. Baffles **180** extend between housing **112** and an end of annular particulate filter **142**. A chemically absorbent outer filter **144** extends between particulate filter **142** and air exhaust **162**. Lamp **50** through the annulus formed by the particulate filter **140** and the annulus formed by dielectric body **30**. As well as the inner and outer annular wire mesh **66, 68** associated with the dielectric body, there is an inner and outer wire mesh **166, 168** associated with the filters **140, 142**. Like meshes **66, 68**, meshes **166, 168** are polarised with a voltage source (not shown). With purifier **100**, when blower **120** is activated, air flows out from the blower into dielectric body **30**, then out from the body to between body **30** and the wall of housing **112**. Air then passes into particulate filter **40**, then through outer filter **42** and out exhaust **162**. Unlike purifier **10** (**Figure 1**), there are no filters surrounding dielectric body **30**. Instead, filters **140, 142**, while concentric with lamp **50**, are separate from the body **30**. With this arrangement, UV light falls directly on the particulate and chemical filters. Appropriate screen meshes could be added to enhance UV2 in the cavity **134** inside the two filters **140, 142**. In addition, photoelectric effect mesh electrodes **166, 168**, if added to filters **40** and **42**, enhance their effectiveness. Instead of a mesh electrode, one method of producing a cathode might entail a coating of cesium iodide or similar material on an inner face of one of the filters. This coating would absorb wavelengths shorter than 185 NM and produce photo-electrons at such wavelengths. It would also be transparent at wavelengths longer than 200 NM. Thus, the cathode would inhibit the emission of UV1 past filters **140, 142** by blocking the ozone

producing UV but still allow UV2 and UV3 to be emitted which would sterilize the filters **140, 142** and aid photochemical processes.

A basic purifier in accordance with this invention would comprise a source of UV which irradiates a suitable dielectric body interposed in the airflow path of the purifier. The effectiveness of the purifier is enhanced by the addition of a cathode and anode to attract and trap charged particles for UV irradiation. Further improvement in efficiency is obtained with the addition of the each of the other features described, such as the described filters and coatings.

Other modifications will be apparent to those skilled in the art and, therefore, the ambit of the invention is set out in the claims herefollowing.

WHAT IS CLAIMED IS:

1. An air purifier comprising:

an air flow path;

a dielectric body which is porous to air and transmissive to ultraviolet light interposed across said air flow path; and

a source of ultraviolet light for emitting ultraviolet light such that ultraviolet light is present in said dielectric body.

2. The air purifier of claim 1 further comprising an anode and cathode in said dielectric body.

3. The air purifier of claim 1 wherein said source of ultraviolet light is also for emitting ultraviolet light such that ultraviolet light is present in said airflow path upstream of said dielectric body.

4. The air purifier of claim 3 wherein said source of ultraviolet light emits ultraviolet light at a first wavelength in a range of 160 to 185 nm and at a second wavelength in a range of 185 to 300 nm.

5. The air purifier of claim 4 wherein said source of ultraviolet light is arranged to emit ultraviolet light such that ultraviolet light at least at said first wavelength is present upstream of said dielectric body and ultraviolet light at said second wavelength is present in said dielectric body.

6. The air purifier of claim 5 wherein said dielectric body more strongly absorbs ultraviolet light at said first wavelength than light at said second wavelength.

7. The air purifier of claim 1 wherein said dielectric body comprises silica.

8. The air purifier of claim 1 wherein said dielectric body comprises silica gel.

9. The air purifier of claim 1 wherein said dielectric body comprises silica granules.

10. The air purifier of claim 1 wherein said dielectric body comprises quartz fibres.

11. The air purifier of claim 10 wherein said quartz fibres are coated with a silica coating.

12. The air purifier of claim 1 wherein said dielectric material comprises alumina fibres.

13. The air purifier of claim 1 wherein said cathode has a coating which is highly reflective of ultraviolet light.

14. The air purifier of claim 12 wherein said coating comprises rhodium coated aluminum.

15. The air purifier of claim 1 wherein said dielectric body comprises a material which strongly attaches to water and ozone.

16. The air purifier of claim 1 wherein said dielectric body has a pore size sufficiently large to admit ozone and water molecules and sufficiently small to enhance attachment of water and ozone to said dielectric body.

17. The air purifier of claim 5 further comprising a mesh surrounding said dielectric body having a mesh size at least an order of magnitude less than said second wavelength.

18. The air purifier of claim 5 wherein said source of ultraviolet light also emits ultraviolet light at a third wavelength about 300 nm.

19. The air purifier of claim 18 further comprising a filter in said airflow path downstream of said dielectric body, said filter being porous to air, said filter arranged for trapping biological fragments.

20. The air purifier of claim 19 wherein at least one of said dielectric body and said filter has a photocatalytic material.

21. The air purifier of claim 20 wherein said photocatalytic material is TiO_2.

22. The air purifier of claim 5 wherein said dielectric body is annular and said source of ultraviolet light emits within a central cavity of said dielectric body.

23. The air purifier of claim 22 wherein said source of ultraviolet light a lamp extending within said cavity.

24. The air purifier of claim 23 wherein said lamp has a silica gel coating.

25. The air purifier of claim 22 wherein said central cavity is sized so that a preponderance of ultraviolet light at said first wavelength is absorbed in said central cavity.

26. An air purifier comprising:

an air flow path;

a dielectric body interposed across said air flow path, said dielectric body being porous to air and fabricated of at least one of silica, silicon dioxide, aluminum oxide, magnesium fluoride, calcium fluoride, barium fluoride, strontium fluoride, lithium fluoride, quartz and sapphire; and

a source of ultraviolet light for emitting ultraviolet ("UV") light such that ultraviolet light is present in said dielectric body.

27. The air purifier of claim 26 wherein said source of UV light is arranged for emitting UV1 light in said airflow path upstream of said dielectric body and UV2 light such that UV2 light is present in said dielectric body.

28. A method of air purification comprising:

passing contaminated air through a dielectric body which is porous to air and transmissive of ultraviolet ("UV") radiation; and

UV irradiating said dielectric body.

29. The method of claim 28 wherein said UV irradiating said dielectric body comprises UV irradiating with UV2 radiation.

30. The method of claim 29 further comprising irradiating said airflow path upstream of said dielectric body with at least UV1 radiation.

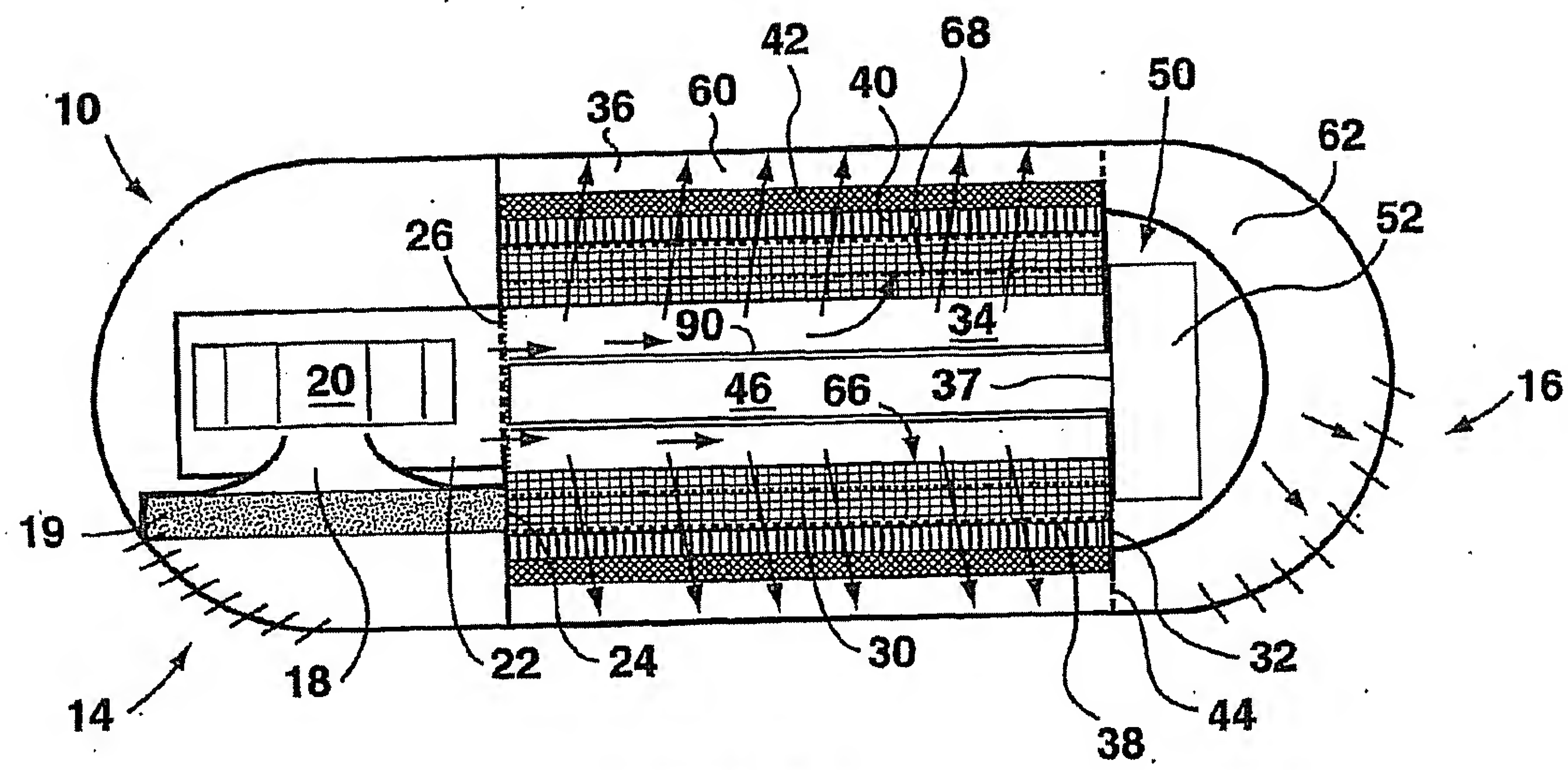
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FIG. 1

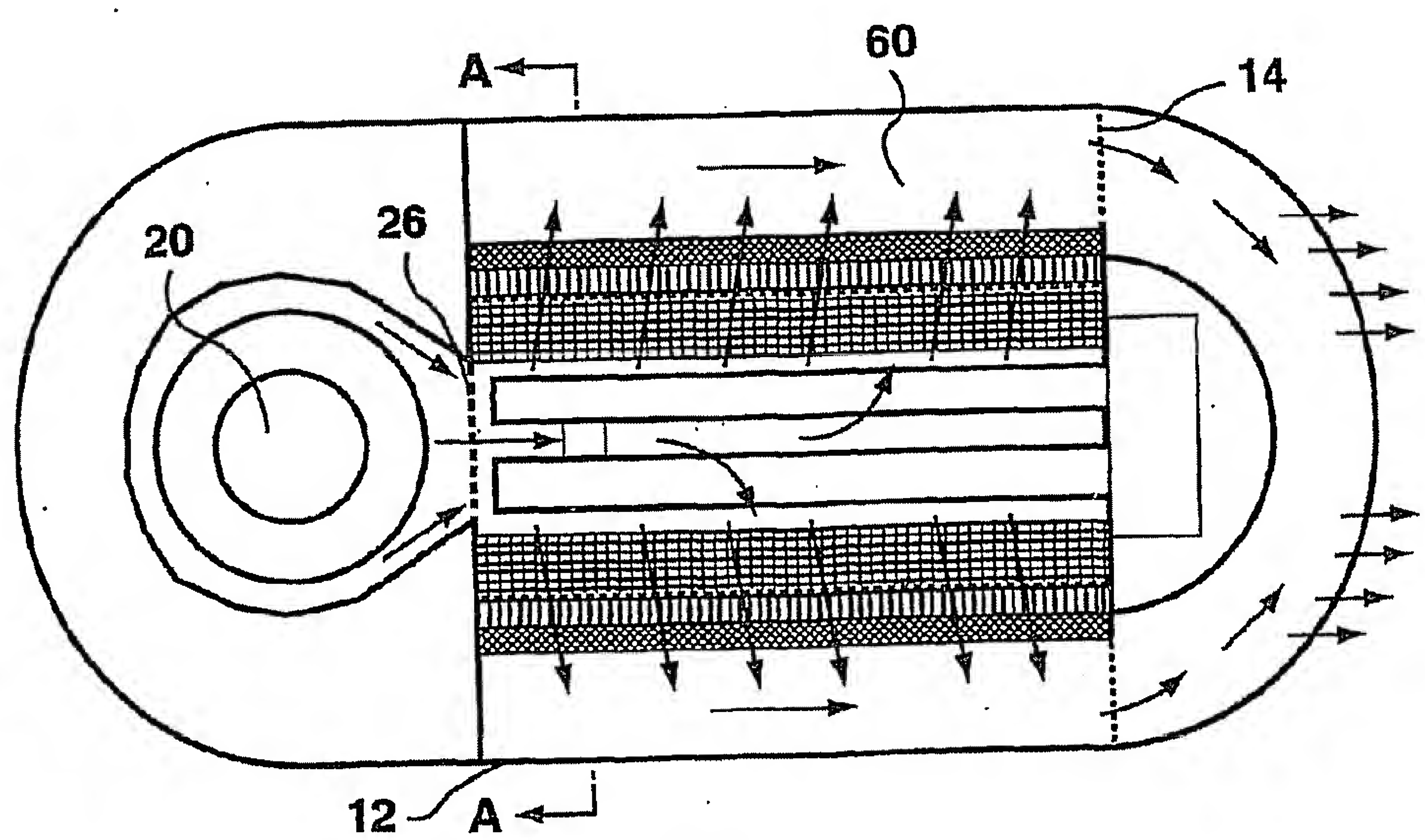
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FIG. 2

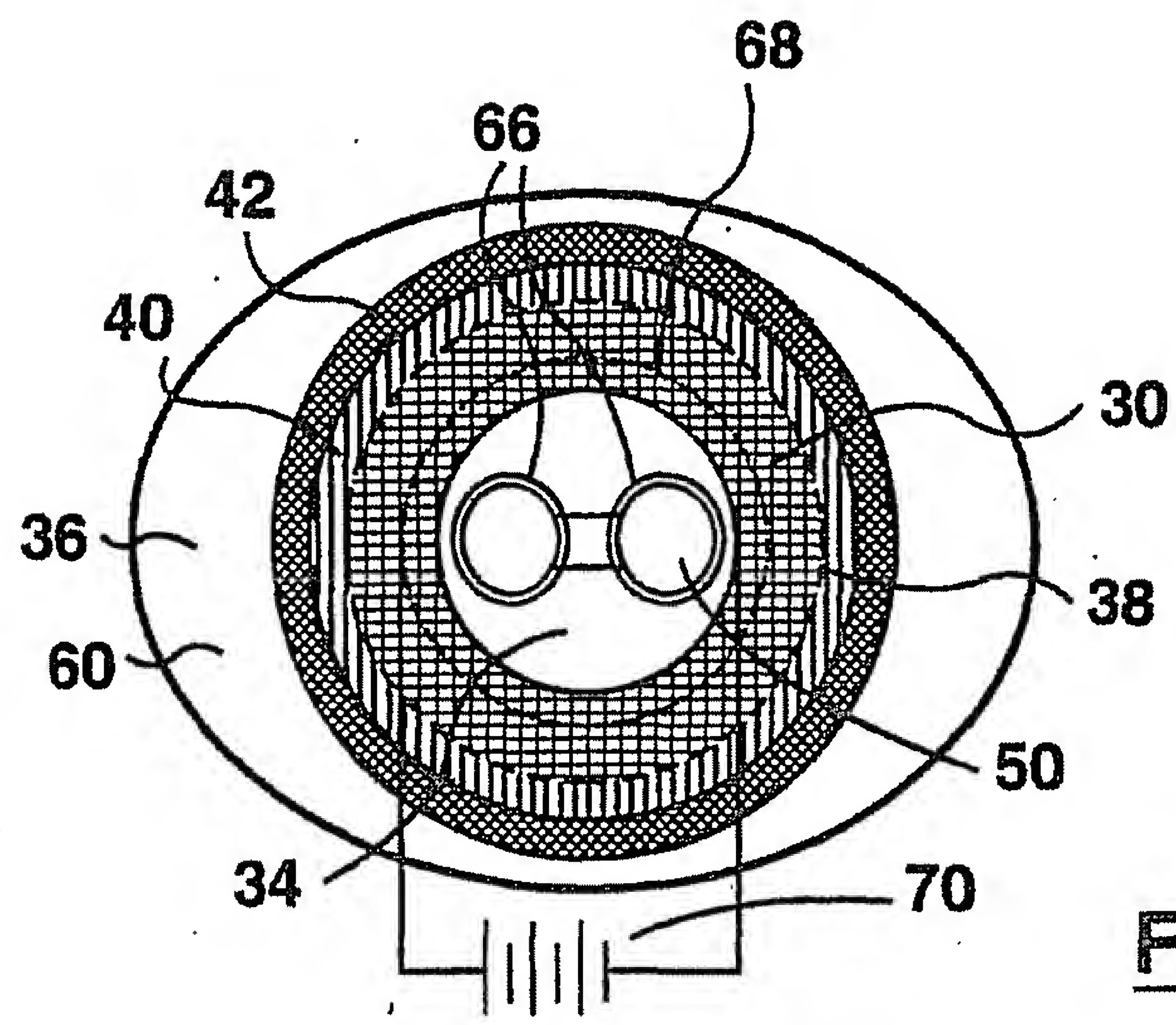
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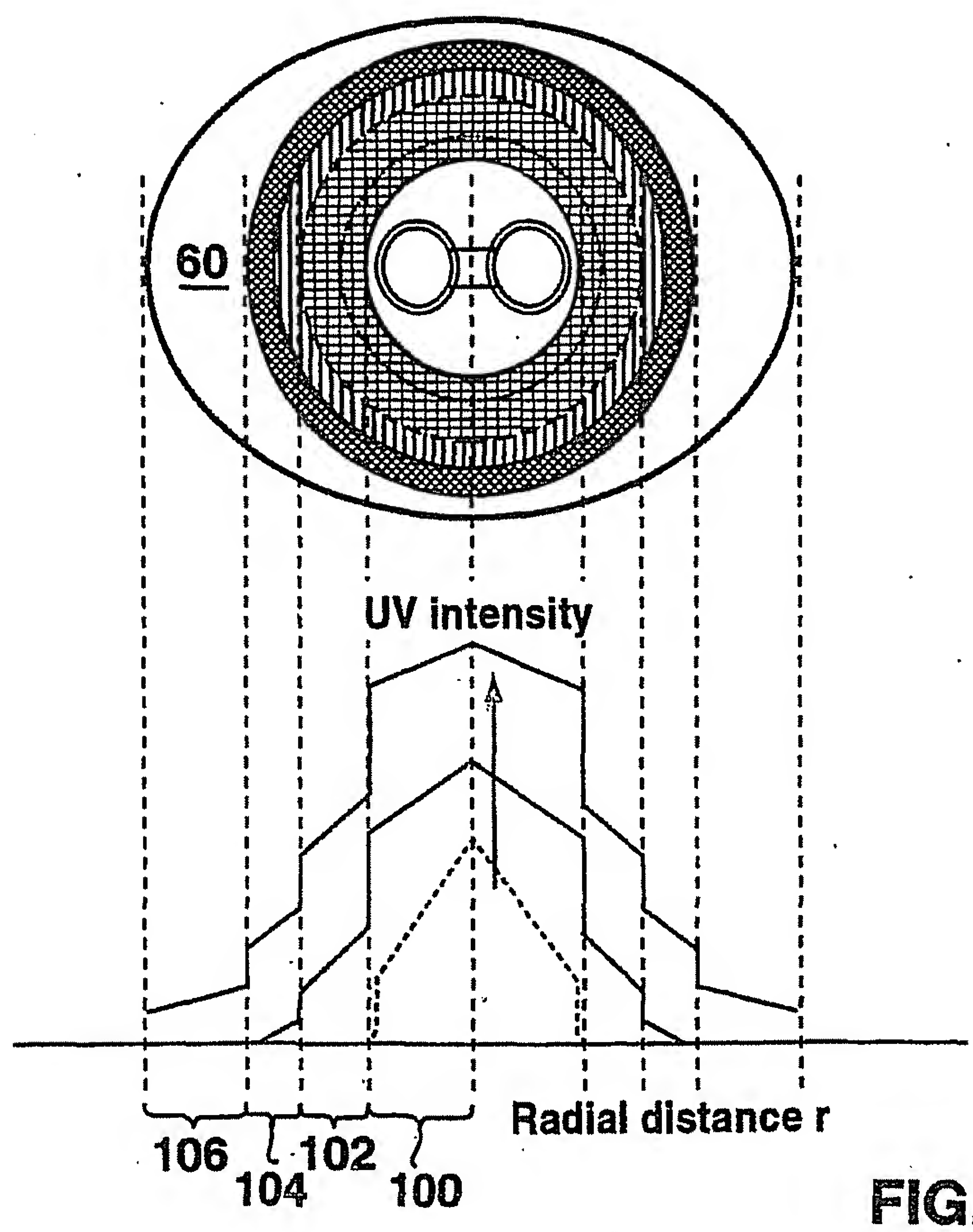
FIG. 3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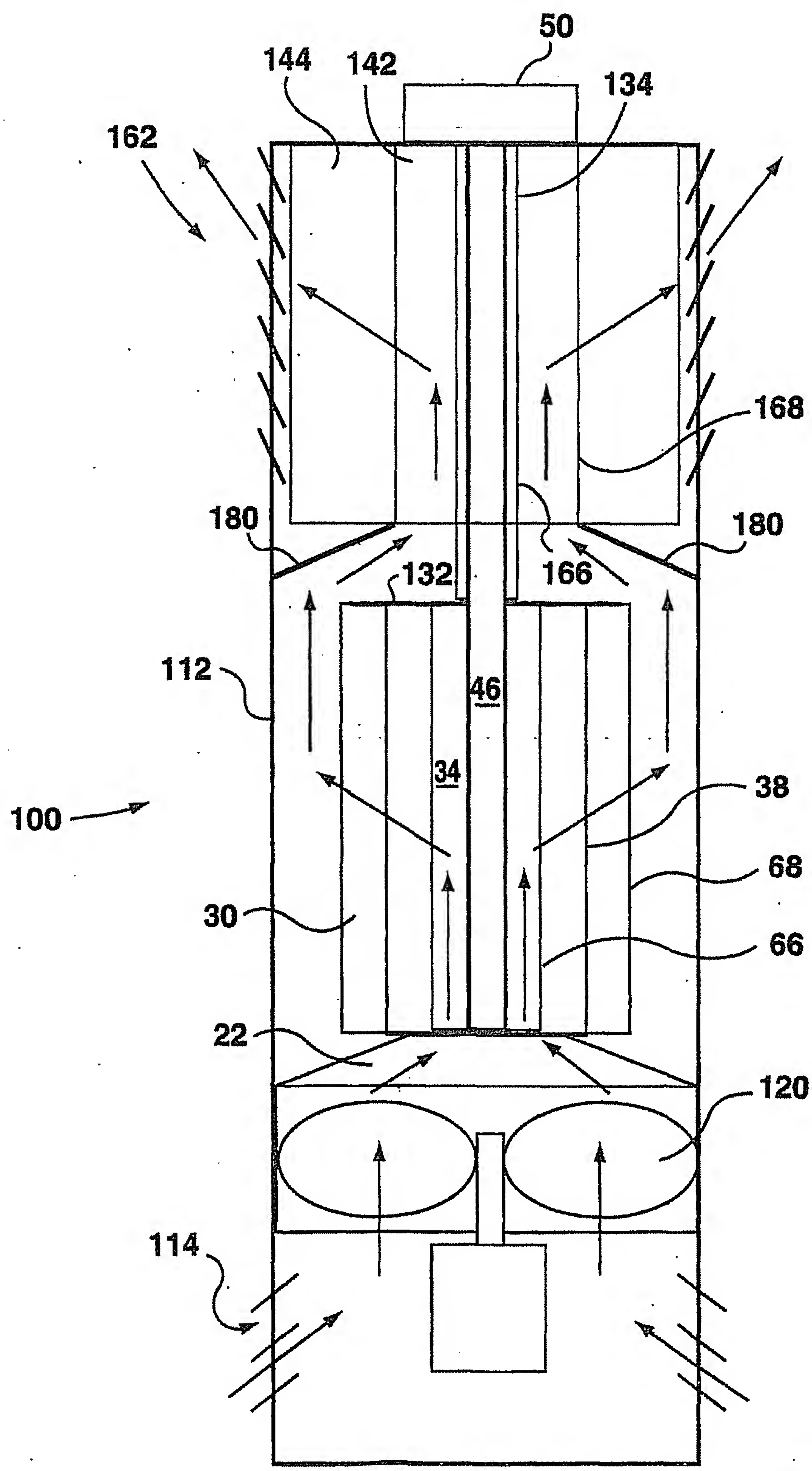
UV intensity
Radial distance r
106
104
102
100

FIG. 3A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114

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 02/00420

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61L9/20 A61L9/00 A61L9/015 F24F3/16 B01J19/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61L F24F B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 198 36 619 A (QUARK SYSTEMS CO) 12 August 1999 (1999-08-12)	1,3, 7-10,15, 16,26-30
Y	column 1, line 3-37	4-6, 17-19, 22,23
	column 8, line 9-24 column 8, line 49 -column 9, line 30; figures 12-15	
X	US 5 330 722 A (PICK WILLIAM E ET AL) 19 July 1994 (1994-07-19)	1-3,10, 13,15, 16,26-30
Y	column 9, line 4 -column 10, line 42; figures	4-6, 17-19, 22,23

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
7 August 2002	14/08/2002

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	page 4, line 8 -page 9, line 13; figures	4-6, 17-23
Y	US 5 656 242 A (MORROW WILLIAM ET AL) 12 August 1997 (1997-08-12) cited in the application column 2, line 37 -column 4, line 52; figures	4-6, 17-23

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